

DRAFT

FREQUENCY PROVISIONS FOR THE SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM (AIS)

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OBJECTIVE

This paper provides a general discussion of Automatic Identification Systems (AIS) and their associated frequency issues and requirements within the United States.

BACKGROUND

AIS is a shipborne transponder-based navigation safety system that serves as the foundation for the Vessel Traffic Service (VTS) being established in New Orleans by the Coast Guard under the Ports And Waterway Safety System (PAWSS) project. AIS implementation is based on technical standards established by the ITU (International Telecommunications Union). The current implementation in New Orleans is based on AIS standard Recommendation ITU-R M.825-3 (DSC-based), which will be updated in the future to the new standard for Universal Shipborne AIS, Recommendation ITU-R M.1371. The Coast Guard and many port authorities are anxious to implement AIS in other ports and waterways in the United States, and it is envisioned that all will one day take advantage of this technology. AIS facilitates the efficient exchange of data between ships and between shore stations and ships that have been fitted with appropriate equipment. AIS responds to the mariners' need for timely, relevant and accurate information delivered in an unobtrusive manner. It is an autonomous, automatic, continuous system that operates in broadcast and interrogation modes. The AIS requires dedicated frequencies in order to operate safely and reliably.

In selecting frequencies to meet AIS requirements, authorities may only use those frequencies within Appendix S18 of the international Radio Regulations (from the S18 table of frequency channels between 156.025-157.425 MHz and 160.625-162.025 MHz). Authorities should utilize techniques established by Recommendation ITU-R M.1084-2 for deriving any new frequencies from within Appendix S18 of the Radio Regulations. The 1997 World Radio Conference (WRC-97) also provided guidelines for obtaining additional spectrum where required via footnotes to Appendix S18.

AIS OPERATING MODES AND FREQUENCY REQUIREMENTS

AIS normally operates autonomously in a self-organized "ship-ship" mode, unless a shore station (such as a VTS area) designates a wide area "ship-shore" network for all ships and shore users in certain areas. The UAIS standard, Recommendation ITU-R M.1371, specifies two operating frequency channels, AIS1 and AIS2, and these channels are required to operate simultaneously and in parallel. On the high seas, for "ship-ship" use, these channels are channels 87B and 88B, as designated by the WRC-97. The WRC-97 also provided for regional AIS channels to be designated where required, such as within VTS areas and/or within national boundaries.

In VTS areas, “ship-ship” and “ship-shore” modes operate independently and in parallel. Separate dedicated frequencies are required to support each of the two operating modes; “ship-ship” needs two dedicated simplex frequency channels, and “ship-shore” typically needs two dedicated duplex frequency channels. Annex 1 illustrates the functions of AIS, and these functions determine the frequency requirements.

Vessel Traffic Services (VTS) need duplex channels (see Annex 1 for “ship-shore” functionality with duplex channels) in order to perform the required services and functions. For any VTS that encompasses large geographic areas served by multiple communications sites, typically two duplex channels will be required (although three channels may actually be required in some special cases, such as Puget Sound) in order to avoid radio frequency interference between adjacent tower sites. In areas with more than two tower sites, towers can alternate their use of the two frequency channels along the waterway for spectrum efficiency.

AIS must be able to operate in “ship-ship” mode everywhere and at all times. Thus, the shipborne AIS is required to simultaneously support both “ship-shore” and “ship-ship” modes on two separate channels in a VTS area, as illustrated in Annex 1. To meet this requirement and mitigate the effects of radio frequency interference (since one channel may be jammed due to interference), shipborne AIS transponders are designed to operate on two frequency channels simultaneously. The Universal AIS standard provides for automatic channel switching (channel management, using DSC and frequency-agile AIS transponders) and for duplex as well as simplex channels.

FREQUENCY TYPES AND THE NUMBER OF FREQUENCIES

In response to a request from the International Maritime Organization (IMO), the WRC-97 (the 1997 World Radio Conference) designated the use of two frequency channels within RR Appendix S18 (the VHF maritime band) for AIS use on the high seas. These channels, 87B and 88B, were derived from the duplex channels 87 and 88, which were previously designated for VHF marine public correspondence. Two channels were selected to increase capacity and mitigate RF interference.

The “upper legs” (B-side) of these duplex (paired frequency) ship/coast (A/B) channels (channels 87 and 88) were chosen for this service because these “upper legs” are the “coast frequencies” utilized by shore stations (ships’ radios do not normally transmit on these frequencies), thus avoiding harmful interference to the ships’ AIS transponders. The WRC-97 also provided for administrations to designate “regional frequency channels for AIS” where channels 87B and 88B are unavailable and, if necessary, to derive new Appendix S18 channels using Recommendation ITU-R M.1084-2 (simplex use of duplex channels and/or 12.5 KHz narrowband channels). The WRC-97 further stated that “these regions should be as large as possible” for navigation safety purposes. Within a VTS/AIS designated area, AIS channel switching is accomplished when the shore stations switch ships’ transponders to VTS/AIS designated working frequencies. Switching of any frequencies can be done via several methods which include: automatic switching by the shore base stations, manual switching by the AIS operator on the ship, or automatic switching by the use of imbedded data base within the AIS transponder or an interconnected terminal (AIS display system or electronic chart display system) onboard the ship. Any switching of channels

should be minimized to ensure stability of the system. Since the “ship-ship” mode must run concurrently with “ship-shore” mode on separate regionally/nationally-dedicated channel(s) that are not dependent on shore-based channel switching, navigation safety cannot be impaired by shore-based system problems. In the United States, the WRC-designated AIS “high seas channels” 87B and 88B are unavailable due to pre-existing conflicting assignments. Therefore, two alternative national “ship-ship” AIS frequencies must be designated for use in US waters. Channels 87B and 88B will likely be used in the “high seas” areas, but the AIS transponders will be switched upon entering the designated waters (see Figure 4 of Appendix 1 for an illustration of frequency channel use in “high seas,” regions, and “ship-shore” service areas). For regions within the United States, two duplex AIS channels should be designated for each region (with a provision to designate a third channel only where needed) for “ship-shore” use within VTS designated areas, and the channel switching can be implemented according to the standard AIS ship-shore automatic channel management protocol.

AIS STANDARDS AND FREQUENCY USE

AIS frequency requirements must consider the two applicable AIS standards, the current standard for AIS, Recommendation ITU-R M.825-3 (DSC-based), and the new standard for the Universal Shipborne AIS, Recommendation ITU-R M.1371. All AIS transponders at some future date are expected to be in accordance with the new Universal AIS standard. Examples of the two standards and their frequency uses are shown in APPENDIX 1.

DESIGNATING FREQUENCIES FOR AIS IN THE UNITED STATES

Considerations for dedicated frequencies to meet AIS requirements (two simplex frequency channels and two duplex channels) in the U.S. should include the need to use frequencies within Appendix S18 of the international Radio Regulations (from the S18 table of frequency channels between 156.025-157.425 MHz and 160.625-162.025 MHz) and the need to utilize techniques established by Recommendation ITU-R M.1084-2 for deriving any new frequencies from within Appendix S18 in accordance with the WRC-97 guidelines set forth in the footnotes to Appendix S18. By following these standards and guidelines, the United States will be able to provide frequencies that will support the proposed international mandatory shipborne AIS transponders.

Appendix S18 supports VHF maritime communications worldwide. These channels support a variety of communication functions, including public correspondence, intership and ship-to-coast, coast-to-ship, port operations, calling and various safety functions. Safety functions include distress, search and rescue, ship movement, navigation (bridge-to-bridge) communications, and maritime safety information broadcasts.

Recommendation ITU-R M.1084-2 provides methods for administrations to derive new frequency channels, where needed, that could be designated for AIS operation. One method implements the simplex use of duplex channels. This method has already been used by the FCC in the U.S. to split the duplex marine channels and to re-designate the “upper legs” (B-sides) for non-maritime use. Another method proposes the interleaving of 12.5 KHz narrowband channels. This method was evaluated by NTIA and the USCG in the PAWSS environment in New Orleans for narrowband

AIS transponders, and the preliminary test results indicate that AIS operation on the 12.5 KHz interstitial duplex channels is interoperable (with conditions) with voice operations on the adjacent 25 KHz duplex public correspondence channels. The conditions for interoperability are: 1.) that both the interstitial 12.5 KHz AIS channel and the adjacent 25 KHz public correspondence channels are operated in duplex mode, with 4.6 MHz of separation between the transmit and the receive frequencies, as specified in Appendix S18, and 2.) that the shore stations operating the 12.5 KHz AIS duplex channels are geographically separated from users of the adjacent 25 KHz duplex voice channels by one mile or more.

Within the U.S., both the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) are the federal agencies that regulate the use of the Appendix 18 VHF maritime spectrum. This is made up of 25 KHz channels with Government and non-Government assignments. FIGURE 3 illustrates the assignments of the Appendix S18 channels in the United States. Two groups of Appendix 18 channels have been assigned to the federal government, one on each side of the marine VHF Public Correspondence (VPC) band. The 25 KHz federal government channels below VHF marine public correspondence are channels 21A, 81A, 22A, 82A, 23A, and 83A, and the channel above the VPC band is channel 88B. These channels are shared by various federal government organizations. Note that these channels (A-channels) are derived from simplex use of duplex (A/B) Appendix S18 channels. Since the paired frequencies (B-channels, or “upper legs” which are needed for AIS) to these channels have already been assigned to other non-maritime services by the FCC, these 25 KHz federal government channels, as well as the other (non-government) 25 KHz simplex channels, are unsuitable for AIS implementation.

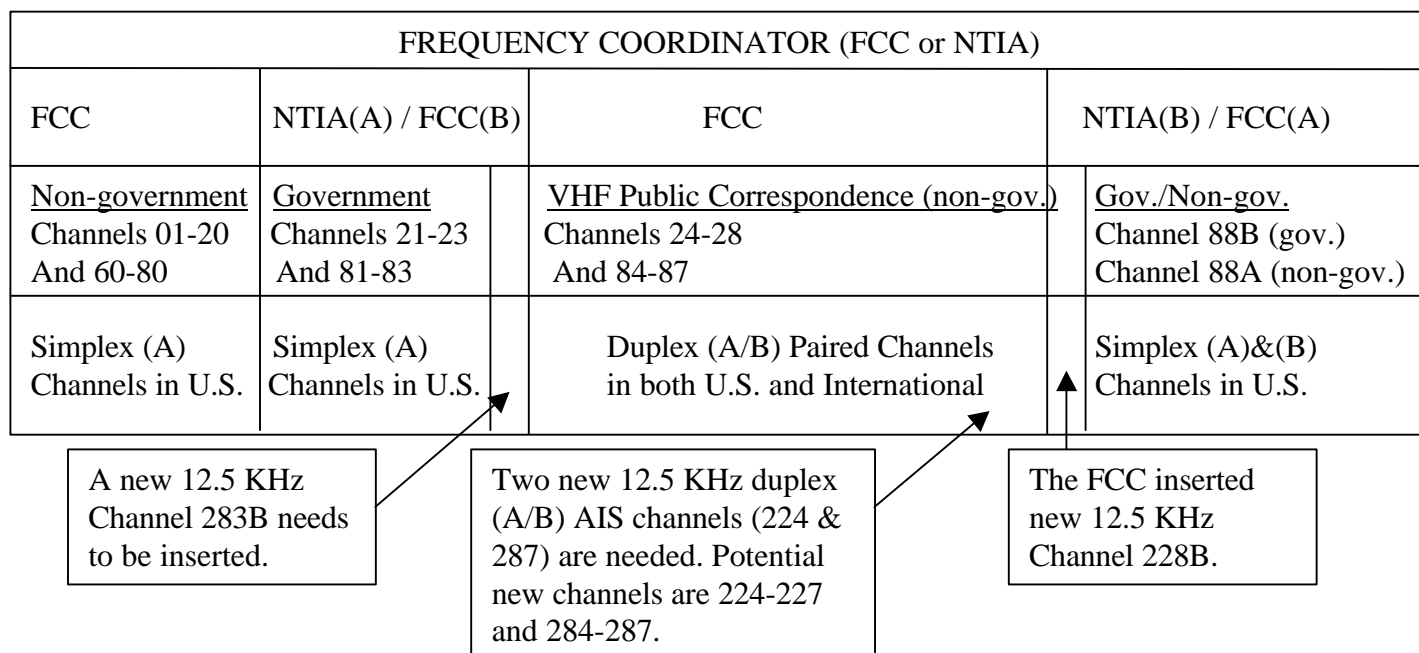


FIGURE 3

Since n **Appendix S18 Channel Assignments in the United States** bject to frequency switching by shore stations, dedicated nationwide frequencies should be assigned for

these ship-ship AIS operations within US control. Frequency assignments for ship stations (for ship-ship AIS operations) should also consider non-public correspondence frequencies since ship stations are currently authorized to use VHF duplex marine public correspondence channels only in conjunction with a licensed coast station.

For shore stations (to support the required ship-shore VTS operations), duplex channels (A/B paired frequencies) are required in order to provide for a wide area information network service exchange in VTS areas. Of the 35 duplex channels listed in Appendix S18 of the ITU Radio Regulations, only nine remain available for maritime service in the United States due to past decisions of the government. Note from FIGURE 3 that all the channels from 01-23 and 60-83, both government and non-government, as well as channel 88, have been made simplex by the FCC's past rulemaking actions, with the A-sides retained for maritime use and the B-sides re-assigned for non-maritime use. The remaining nine 25 KHz duplex channels are contained within the VHF marine public correspondence service, which are Channels 24, 84, 25, 85, 26, 86, 27, 87, and 28. It should be noted that the VHF marine public correspondence service providers typically have a license for only one or two channels per service area.

Since existing wideband 25 KHz channels have already been designated within the VHF maritime band, it has become necessary for the US to consider 12.5 KHz interstitial channels in accordance with ITU-R M.1084-2 for AIS operations. Since AIS implementation requires duplex channels (either B-side "upper legs" or duplex pairs), these potential new interstitial channels must be implemented within the VHF maritime band. As such, potential candidate frequencies could be selected from within the Public Correspondence Band (the only remaining duplex channels in the US) and would comprise the channels numbered 224, 225, 226, 227, 284, 285, 286, and 287 as shown in FIGURE 3. This method was investigated by the USCG and the National Telecommunications and Information Administration (NTIA), in cooperation with the Radio Technical Commission for Maritime Services (RTCM) Special Committee SC101. The result of the investigation showed that 25 KHz voice radios and 12.5 KHz voice radios can be made to be interoperable with conditions.¹ However, the introduction of new 12.5 KHz voice radios into the existing 25 KHz environment must be done slowly and carefully in order to ensure that no interference occurs to users of existing 25 KHz channelized maritime radios. It should be noted that the NTIA report showed better compatibility between 12.5 KHz AIS transponders and 25 KHz voice radios than between 12.5 KHz voice radios and 25 KHz voice radios. Subsequent tests have been performed in the New Orleans PAWSS VTS (since this is the USCG's test port) to determine the levels of compatibility and the separation criteria for interoperability between VHF public correspondence service on 25 KHz duplex channels and AIS service on 12.5 KHz interstitial duplex channels. The preliminary test results indicate that the two systems are interoperable, provided that the AIS shore base stations are separated by a reasonable distance (one mile or more). This performance is due to: 1.) the robust modems of the AIS transponders, 2.) the extremely short AIS data packet duration (almost imperceptible "noise-like" data burst),

¹ Sole, R., Sanders, F. and Bedford, B., Assessment of Compatibility Between 25 and 12.5 KHz Channelized marine Radios, NTIA-TR 97-343, U.S. Department of Commerce, August 1997.

and 3.) the 4.6 MHz separation between the Appendix S18 duplex paired frequencies (i.e., the separation between the transmit frequencies and the receive frequencies).

The FCC addressed the need for obtaining frequencies for AIS, in its “Third Report and Order and Memorandum Opinion and Order,” FCC 98-151, released: July 9, 1998. The R&O noted the following: 1) that duplex 12.5 KHz interstitial channels from within the VHF marine public correspondence band should be used for AIS, 2) that two interstitial (interleaved 12.5 KHz narrowband) duplex channels would be needed (in each maritime region) for “ship-shore” use, and 3) that channel 228B (162.0125 MHz) should be designated for AIS on a nationwide basis for “ship-ship” use.

Furthermore, the FCC auctioned on December 3, 1998 (in accordance with the provisions announced earlier in its R&O of July 9, 1998) the VHF duplex marine public correspondence channels. The new auction winners will receive licenses for all the channels in the band with provisions for interference protection for the stations operated by the incumbents (who will retain their current licenses). This auction was conducted on a regional basis (both maritime regions and non-maritime regions) with each of the maritime regions coinciding with the USCG districts. The FCC’s R&O requires the USCG to “negotiate” with the regional auction winner for selecting two interstitial channels for AIS operations. The potential use of interstitial channels within the Public Correspondence band allows a unique opportunity for channels to be dedicated exclusively to AIS operation since they have never been assigned. As a result modifications to the FCC rules under 47CFR80 for equipment that operates on 12.5 KHz channels will, of course, be needed. The apparent auction winner for all maritime regions is MARITEL. Since there is only one apparent auction winner for all maritime regions, the USCG will negotiate with MARITEL for two interstitial frequency channels to be dedicated exclusively for AIS operations on a nationwide basis. Note that the R&O provided that the maritime VHF Public Coast licensees can use the interstitial channels for their own purposes if they have both wideband 25 KHz channels on either side of the interstitial channels. Thus, there is a need for two AIS channels to be dedicated exclusively for AIS in order to provide protection against harmful interference from other uses of these frequencies and also to insure availability of frequencies for AIS where needed in the future. If the USCG is unable to obtain nationwide exclusive dedication of two duplex interstitial channels, then two such channels could be exclusively dedicated for AIS on a region-by-region basis. The two interstitial frequency channels should be selected such that the two channels have a maximum frequency separation in order to provide maximum protection against interference. The channels used in the previous example (channels 224 and 287) would be best suited for designation for AIS because they have the maximum available frequency separation.

The FCC’s R&O recognized the needs for a nationwide AIS ship-ship frequency (although one more is needed to support the new Universal AIS). The 12.5 KHz narrowband channel 228B was designated for three very important reasons: 1.) this channel is currently located (see FIGURE 3) between the highest marine VHF public correspondence 25 KHz channel (channel 28) and the lowest non-maritime federal government 25 KHz channel (channel 88B, 2.) this channel is a new 12.5 KHz channel, and thus it would pose a minimum of conflicts to its assignment to AIS nationwide, 3.) this channel is from a duplex “upper leg”, and as such is not subject to interference from ships’ VHF marine radios. However, as mentioned before, the USCG and

NTIA have already tested for compatibility between 12.5 KHz AIS use and adjacent 25 KHz wideband voice use, and the preliminary test results indicate that AIS use of channel 228B should not cause interoperability problems with the current use of channel 88B.

A second nationwide ship-ship AIS channel (in addition to the one channel 228B provided by the R&O) is needed to support the new Universal AIS standard. Channel 283B could be likewise designated for AIS nationwide, since this channel is also a potential new 12.5 KHz channel that is situated between the highest frequency used in the landmobile service and the lowest VHF marine public correspondence 25 KHz channel (channel 24). Refer to FIGURE 3 for the location of the possible insertion of channel 283B. Designation of both of these channels (228B and 283B) nationwide for AIS would insure that the needs of AIS for navigation safety (for the “ship-ship” operating mode) could be met in the waterways of the United States. The USCG and MARITEL (the FCC auction winner for the VPC maritime regions) can now negotiate for the use of two 12.5 KHz duplex interstitial channels (for the “ship-shore” operating mode) for use by AIS shore stations. Refer to APPENDIX 1 for illustrations of the use of these frequency channels for AIS.

CONCLUSIONS

Nationwide deployment of Universal AIS in the United States is one of the Coast Guard’s primary safety enhancement goals. It is the future foundation for information exchange at vessel traffic services and the Ports and Waterway Safety System (PAWSS) project, it is being delivered at the specific request of the waterway users. The New Orleans AIS test site was implemented under the PAWSS program using the current DSC-AIS standard. It will eventually be updated with the new Universal AIS standard.

The Coast Guard plans to issue a carriage requirement for an AIS-based VTS in New Orleans by July 2000. The Coast Guard and many port authorities in the United States are anxious to implement AIS. The International Maritime Organization (IMO) has initiated actions to amend SOLAS Chap V to include a worldwide carriage requirement for AIS. Immediate steps need to be taken to ensure provisions are made for AIS frequencies in the United States to meet the emerging requirements.

AIS must simultaneously support the “ship-ship” mode of operation as well as the “ship-shore” mode of operation (see ANNEX 1 for a description of the AIS functionality requirements and operating modes). The “ship-ship” mode operates autonomously and requires two simplex frequencies. The “ship-shore” mode will be used in high traffic areas or ports with a VTS or VTIS. Large ship-shore service areas that require more than one communications site for complete coverage will need at least two dedicated duplex AIS frequency channels in order to facilitate channel switching and to avoid radio frequency interference between the sites. Channels selected for AIS use must be exclusively dedicated to AIS to ensure safety.

In response to a request from the IMO, the 1997 World Radio Conference (WRC-97) designated the use of two simplex frequency channels within the VHF maritime band (RR Appendix S18) for ship-ship AIS use on the high seas. These channels, 87B and 88B, were derived from the duplex channels 87 and 88 that had previously been designated for VHF marine public correspondence.

The WRC chose to designate two channels in order to increase capacity and minimize RF interference.

Any considerations for dedicated frequencies to meet the US AIS requirements of two simplex frequency channels and two duplex channels must recognize the need to use frequencies from within Appendix S18 of the international Radio Regulations. This refers to the S18 table of frequency channels between 156.025-157.425 MHz and 160.625-162.025 MHz. Furthermore, frequency considerations should employ the techniques established by Recommendation ITU-R M.1084-2 for deriving new frequencies from within VHF-FM maritime band as well as the guidelines given by WRC-97. By following these standards and guidelines, the United States will be able to provide frequencies to support shipborne AIS transponders that meet future international standards.

The task of designating spectrum for AIS in the United States is complicated because of the past regulatory actions, and recent auctioning the VHF marine Public Correspondence band. Furthermore, the ITU-R AIS standard(s) restricts AIS operations to within the Appendix S18 (VHF marine) frequency band. It would be much simpler if the U.S. could follow the WRC's lead and designate the high seas channels 87B and 88B for AIS "ship-ship" operations nationwide, thereby establishing a seamless worldwide AIS. However, Channels 87B and 88B have been assigned to other uses and are not currently available in the United States. Channel 87B has been auctioned and is licensed to public correspondence providers. Channel 88B is used for law enforcement purposes within federal government, and its use for AIS would have to be coordinated among several other users. Reassigning these frequencies to accommodate AIS would require policy changes and FCC rulemaking.

The FCC recognized the Coast Guard's need for obtaining frequencies for AIS in its "Third Report and Order (R&O) and Memorandum Opinion and Order," FCC 98-151, released: July 9, 1998. The R&O noted the following:

- 1) That the duplex 12.5 KHz interstitial channels in the VHF marine public correspondence band should be used for AIS. (fig 3),
- 2) That two interstitial duplex channels would be needed for use by AIS shore stations, and
- 3) That the designation of channel 228B (162.0125 MHz) be used for a nationwide frequency for "ship-ship" AIS.

On 3 December 1998, the FCC auctioned all the remaining VHF duplex marine public correspondence channels (channels 24-28 and 84-87). Frequencies being auctioned were identified by region as either maritime or non-maritime, with the maritime regions coinciding with Coast Guard districts. This auction was held in accordance with provisions announced in an FCC R&O issued on 9 July 1998. Among these provisions was a stipulation that the incumbent licensees could retain their current licenses, and the new auction winners would receive licenses while providing interference protection to the incumbent. The R&O further provides that the regional auction winner "negotiate" with the Coast Guard to select two interstitial duplex channels for AIS use. The use of interstitial channels within the Public Correspondence band

affords a unique opportunity for channels to be dedicated exclusively to AIS operation since these channels have never been assigned.

The auction winner and apparent licensee for all maritime regions is MARITEL. This simplifies the negotiation process. Note the R&O provided that the incumbent licensees can use the interstitial channels for their own purposes if they already held the license for the wideband 25 KHz channels on either side of the interstitial channels.

AIS needs two dedicated channels for AIS, but identifying these channels is not simple. It is preferred to have nationally-designated channels, but it may be necessary to select different duplex interstitial frequency channels in different regions. If so, channel management methods would have to be implemented by the use of the approved standard methods. Furthermore, the interstitial frequency channels that are chosen would have to be selected such that they have a maximum frequency separation in order to provide maximum protection against interference. The interstitial duplex channels 224 and 287 (see fig. 1 and fig. 2) appear well suited for nationwide AIS designation because they have the maximum available frequency separation.

There remains another critical task that was not provided for in the FCC's R&O. This is the designation of a second nationwide "ship-ship" AIS frequency in addition to 228B. The frequency 283B appears to be a candidate frequency, which is the "upper leg" of channel 283. This second "ship-ship" channel is necessary to support the new Universal AIS standard. Channel 283B meets all the requirements of the AIS standards, and it is not currently being used in the United States. The administration should expedite its designation for AIS as soon as possible. APPENDIX 1 illustrates the AIS standards and their use of these potential channel designations.

RECOMMENDATIONS

1. Pursue the designation of channel 228B as noted by the FCC for use in "ship-ship" AIS operations nationwide (IRAC Reference).
2. Pursue the designation of channel 283B for the second dedicated frequency for "ship-ship" AIS operations nationwide.
3. Complete the negotiations with the apparent auction winner, MARITEL, for identifying two interstitial duplex pairs to be dedicated nationwide for AIS "ship-shore" operations.
4. Petition the FCC for appropriate modifications to the maritime regulations 47CFR80.
5. Petition the FCC for equipment type acceptance provisions for AIS transponders, to include emissions for both 25 KHz and 12.5 KHz channels.
6. Consider expanding the negotiations with the apparent auction winner MARITEL for the possibility of using channel 87 B for ship to ship AIS operations.
7. Explore the possibility of using frequency 88B for AIS.

APPENDIX 1

AIS STANDARDS AND FREQUENCY USE

The current standard requires one dedicated simplex channel for ship-ship operations, two dedicated duplex channels for ship-shore operations, and channel 70 for control (see FIGURE 1).

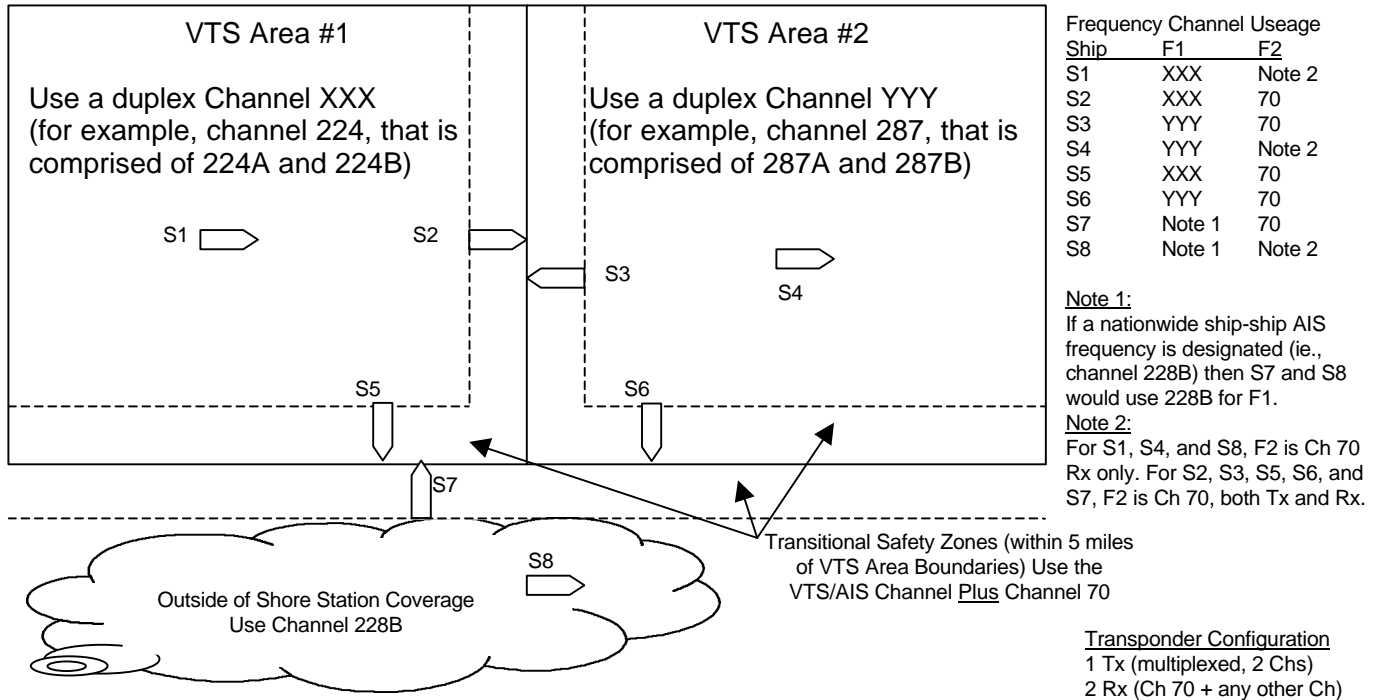


FIGURE 1

Frequency Channels for the Current AIS Standard (DSC)

Since AIS is being implemented for PAWSS in the U.S. with the current standard, the immediate U.S. AIS frequency channel requirements are for four Appendix S18 channels: channel 70, channel 228B, and two duplex channels. Channel 70 is used primarily for shore control and for the transitions between VTS areas. Channel 228B is used for the ship-ship mode outside of the VTS areas, and the two duplex channels are to be used in VTS areas for wide-area ship-shore AIS communications, by and with the USCG or an authorized VTS provider.

The new Universal Shipborne AIS standard requires two dedicated simplex channels for ship-ship operations, two regionally-dedicated duplex channels for ship-shore operations, and channel 70 (for channel management, etc.). This requirement could be met by designating two simplex channels nationwide for ship-ship AIS and utilizing the two duplex channels of FIGURE 1 for ship-shore AIS. Since one simplex narrowband channel (channel 228B) has already been designated, one more similar channel (such as channel 283B) is needed. This new standard still utilizes channel 70 for frequency channel management. FIGURE 2 illustrates the operations of the new Universal AIS using the two simplex narrowband channels 228B and 283B and the duplex channels from FIGURE 1 (channel XXX and channel YYY):

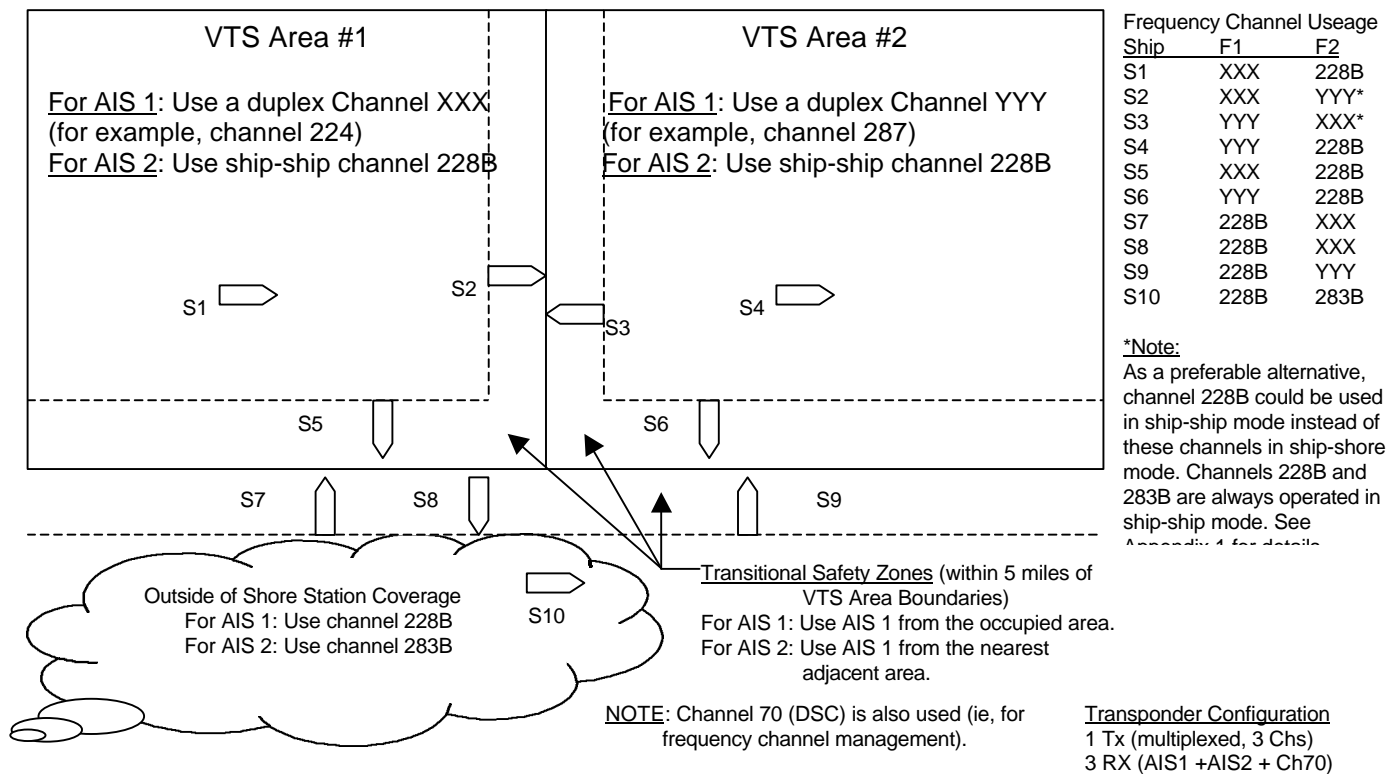


FIGURE 2
Frequency Channels for the New Universal AIS Standard

Note that in the illustrations above (FIGURE 1 and FIGURE 2), channels 283B, 228B, 224 and 287 were selected as examples of how to meet the immediate needs of the current standard and the long range needs of the new Universal AIS standard for ship-shore service for ship-ship service. These channels were selected for these illustrations because they represent a resourceful approach to supporting the transition of AIS from the standard now used in the United States to the new standard that is planned for the implementation of an international carriage requirement. All of these channels are internationally recognized, and they are consistent with the provisions in FCC's latest rulemaking (except that channel 283B must also be designated, following the same rationale as the FCC used to designate channel 228B). Thus, these channels appear to be attractive candidates for AIS designation (assuming that cooperative regulatory actions follow).

The new standard uses TDMA (time division multiple access) for its primary ship-ship and ship-shore operating modes. It also has provisions for limited backward compatibility with DSC-equipped shore stations that utilize Recommendation ITU-R M.825-3 for interrogations and broadcasts on channel 70 and for automatic AIS frequency channel management.

UNIVERSAL AIS CHANNEL MANAGEMENT ALTERNATIVES

The Universal Shipborne AIS is a two-channel parallel operating system with two receivers dedicated to the two TDMA working channels and one transmitter that switches between the two

channels, alternating its transmissions between the two TDMA working channels. The Universal AIS standard provides for regional channel management using a three-zone boundary approach and a possibility of three regional frequencies, where needed (see FIGURE 3 below). On the high seas, these channels, AIS 1 and AIS 2, operate on the WRC-designated channels 87B and 88B, respectively. In regional areas that require separate regional frequency designations, AIS 1 and AIS 2 are switched to regional channels (F1 and F2) and service area channels (FA, FB and FC) in such a way as to provide safe transitions between the service areas (see FIGURE 3). Note that three channels are required to keep the service areas separated if a continuous patchwork of wide area service networks is required. Only two channels (FA and FB) are sufficient in most cases, since waterways (rivers and shorelines) can usually be served from an arrangement of shore stations which can alternate use of the two channels. The system shown uses the primary national region's ship-ship channel (F1) as AIS 2 in the service areas, for spectrum efficiency, since most of these areas border on the national region.

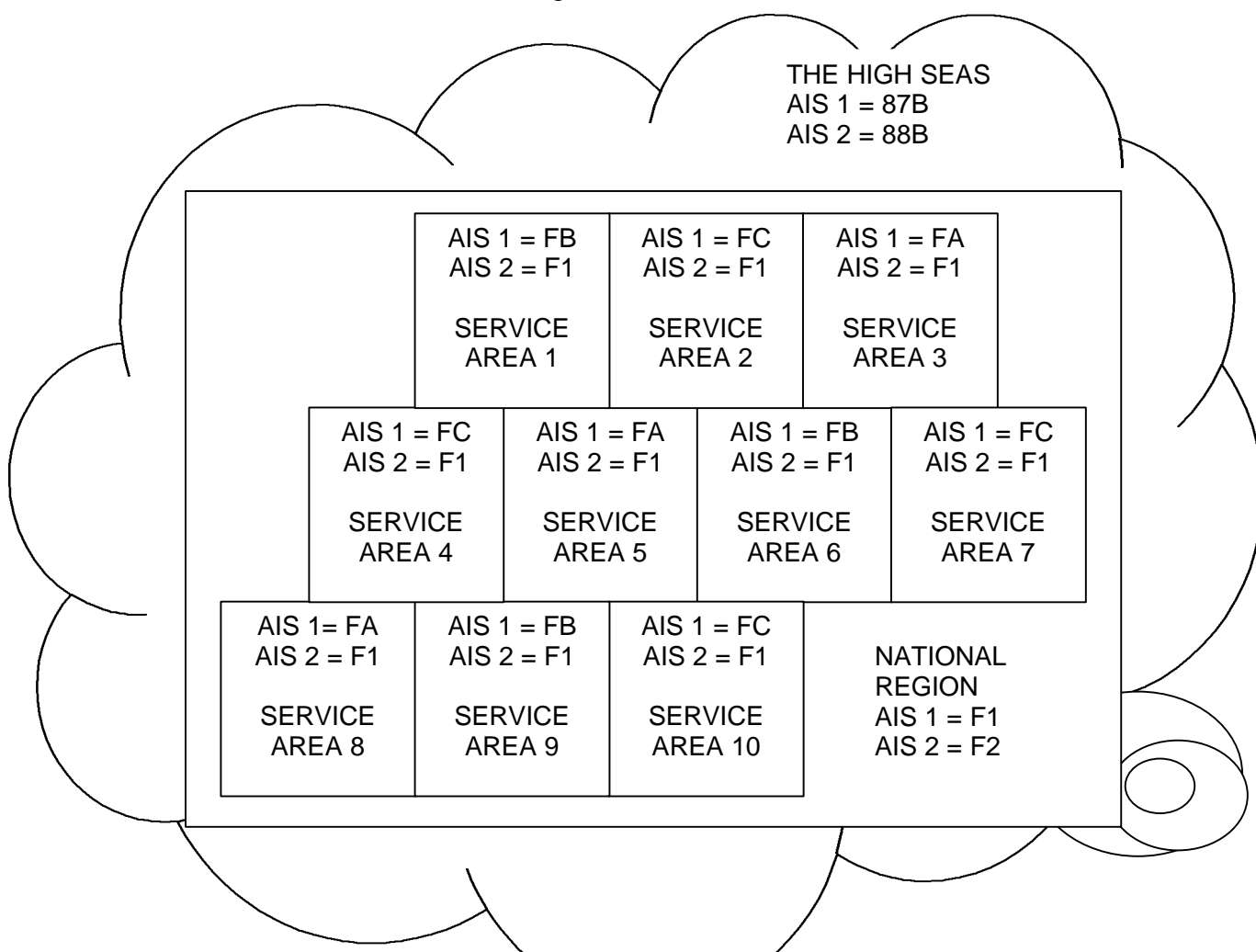


FIGURE 3

The Universal Shipborne AIS is designed to automatically switch AIS 1 and AIS 2 when the ship approaches within 5 miles of the boundary of a region or service area (in accordance with the

standard channel management protocol). The standard specifies the substitution of AIS 2 of the current area for AIS 1 of the closest adjacent area. Inspection of FIGURE 3 will illustrate that this function provides safe passage for ships transiting between regions or service areas where different frequencies are used, since each ship is using at least one of the same frequencies as each other ship in its region or service area plus one of the same frequencies as each other ship within the adjacent region or service area.

However, if only one regional channel is designated that is available for use over the entire region (i.e., the FCC's designation of channel 228B), that one channel could be used in the ship-ship mode everywhere, including the service areas. The shore-based systems in the service areas will operate in the ship-shore mode on their designated channel, FX, and the ships will operate on ship-shore mode in this channel and also on ship-ship mode on the regional channel. FIGURE 4 illustrates the general case and this special case, where the channels used in the special case are in parentheses (F1) when these channels differ from the channels used in the general case.

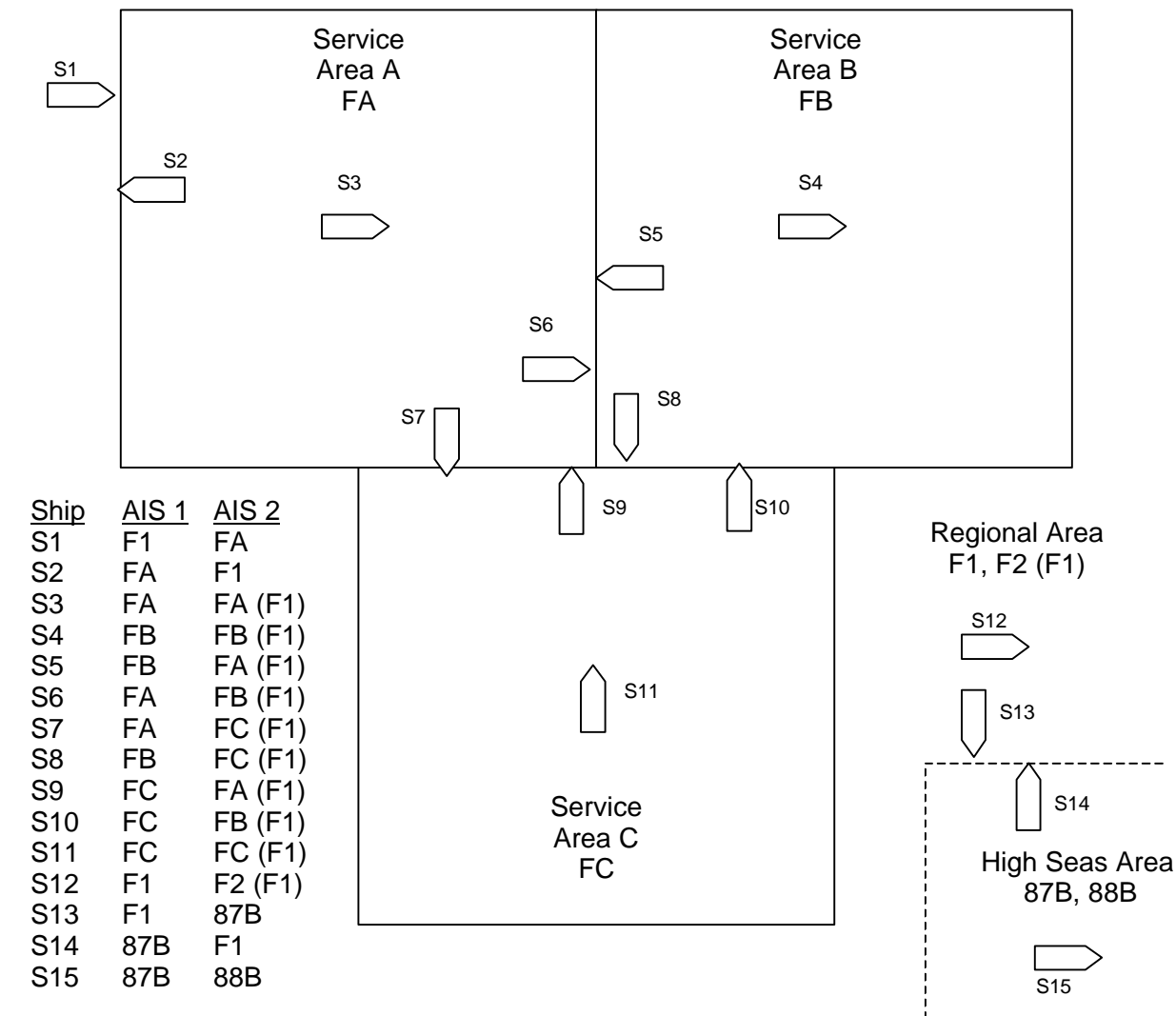
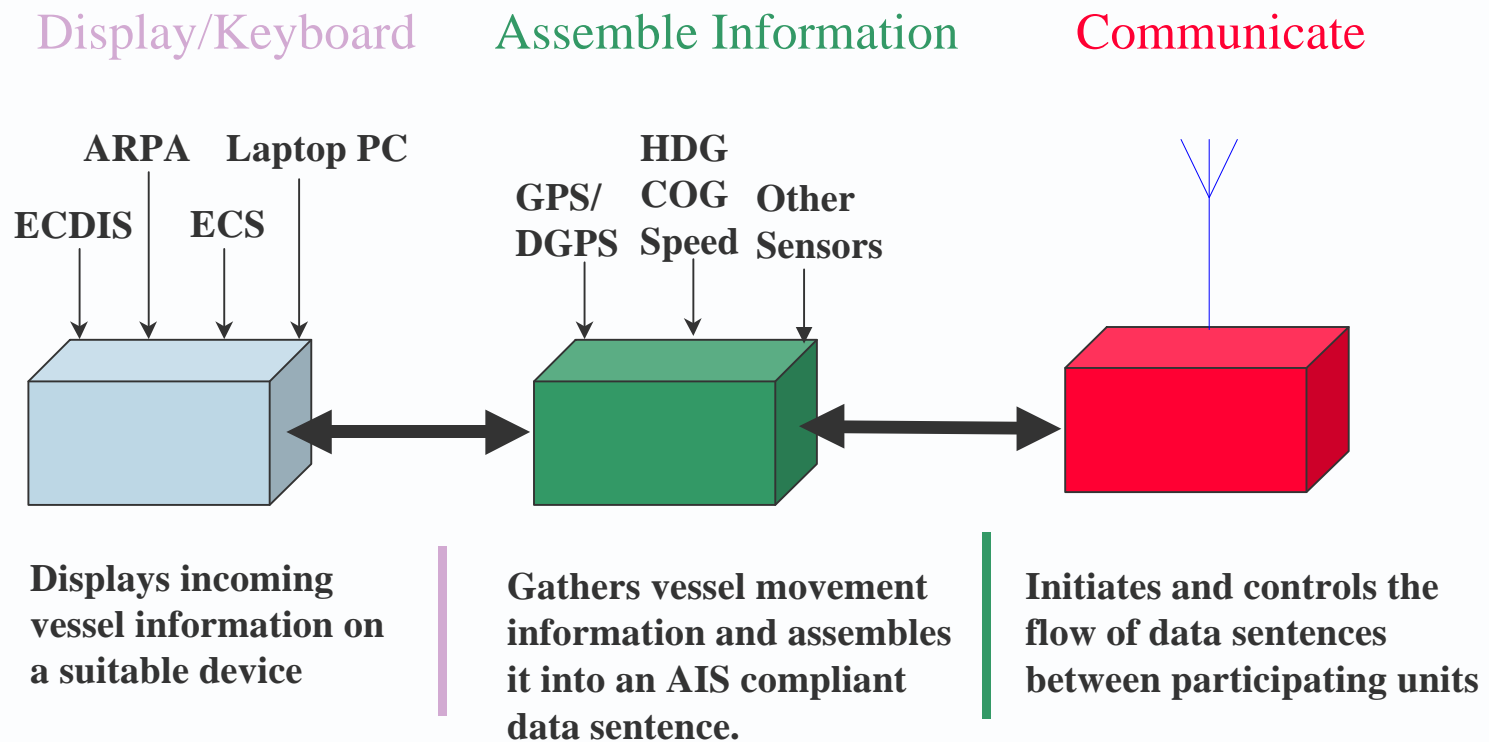


FIGURE 4

ANNEX 1: AIS FUNCTIONALITY

AIS Elements



The Universal AIS

Features and Functions

- Time-division multiple access (TDMA) architecture
 - Provides over 2000 reports/minute/channel
 - Allows hundreds of simultaneous users in a network
- Two-channel system
 - Mitigates RF interference
 - Doubles capacity
 - Provides for safe, seamless channel switching

The Universal AIS

Features and Functions (cont'd)

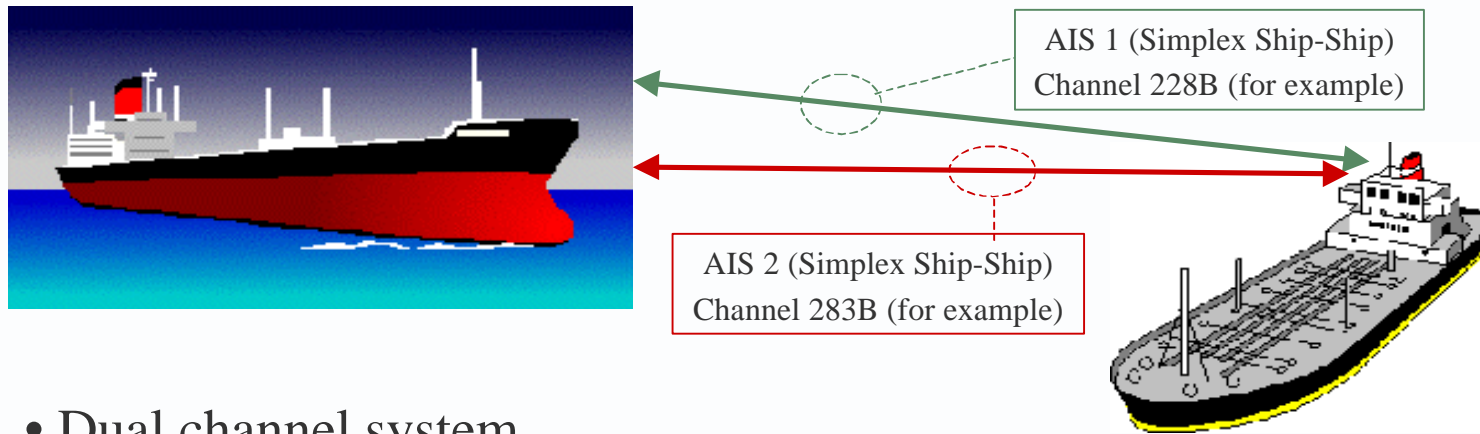
- DSC Compatibility
 - Provides a means of AIS frequency channel management
- Narrowband 12.5 KHz channel compatibility
 - Provides a means of deriving new channels for AIS
 - Fits FCC emissions requirements for narrowband channels
 - Compatible (with limitations) with 25 KHz systems

The Universal AIS

Features and Functions (cont'd)

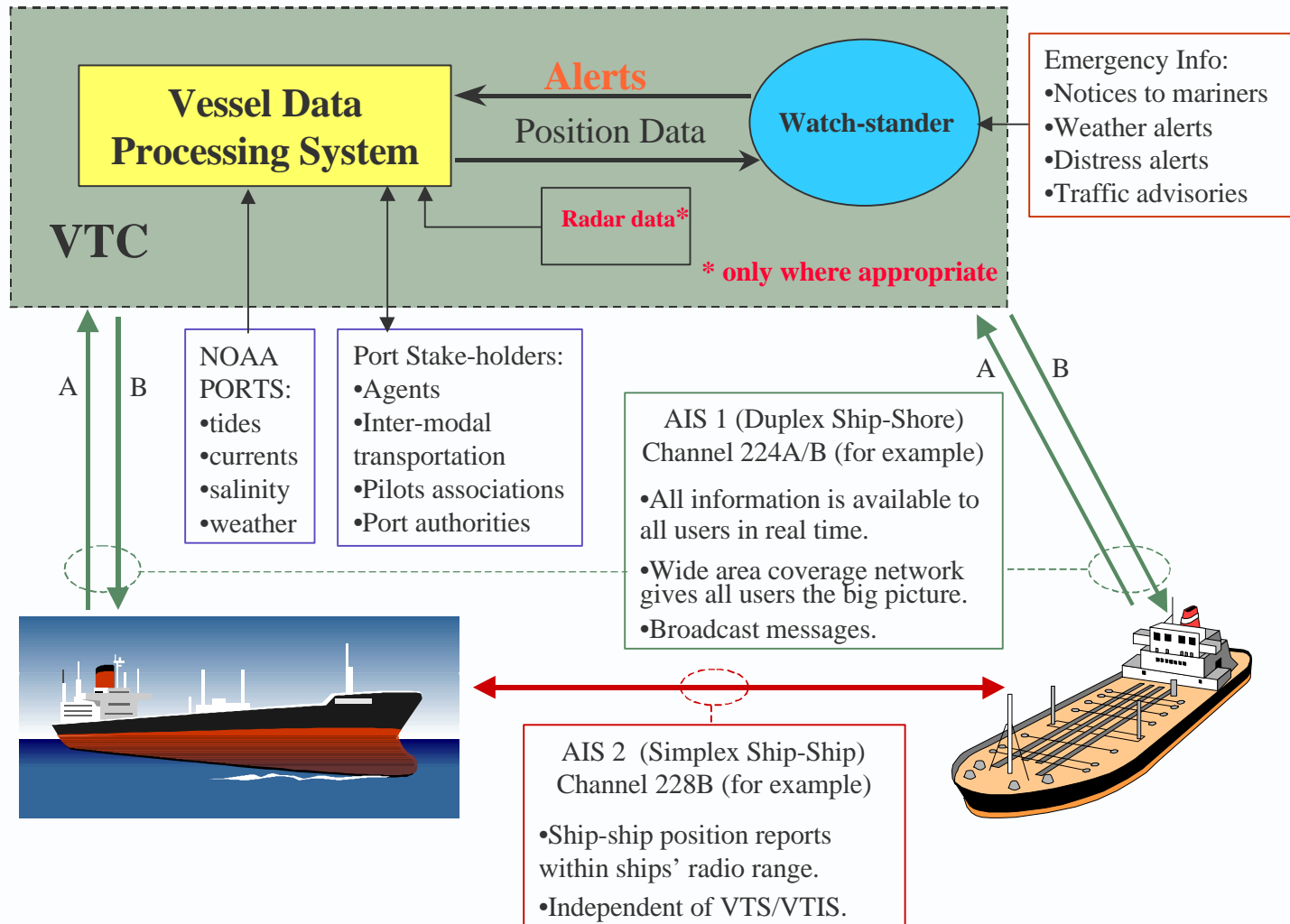
- Duplex channel compatible
 - Facilitates shore repeaters
 - Enable wide-area coverage
 - Allows ships AIS transponders to self-organize error-free transmissions in the wide area network coverage area
 - Facilitates delivery of shore generated information

Ship To Ship AIS



- Dual channel system
 - safe channel switching
 - mitigates RF interference
 - doubles capacity
- Self-organizing, randomized
- Independent of shore stations
- Situational awareness displays
- Ship-ship text messaging
- DSC compatible for frequency channel management
- Simplex use of duplex channels
- Allows for 12.5KHz channels

AIS-based VTS/VTIS (US)



Enhanced AIS (US)

